Sci & Educ (2012) 21:415–422
DOI 10.1007/s11191-011-9377-9

BOOK REVIEW

James Hannam: *God's Philosophers. How the Medieval World Laid the Foundations of Modern Science?*

Icon Books Ltd., London, 2009, ISBN: 978-184831-150-3, 435 pp, Au$ 22.95

Igal Galili

Published online: 7 July 2011

This book presents a panoramic view of the historical period of the Middle Ages from a particular perspective: natural philosophy accompanied with the surrounding areas of theology, technology, medicine, astrology, alchemy, all interwoven among human intellectual activities and interacting with society. The author demonstrates how many accomplishments were produced by the scholars who worked during the 1,000 years of the middle Ages, and how much modern science owes to those scholars. This could seem to be an issue for general curiosity, but it is not, since without awareness of this debt that we owe in science education, we easily make inadequate inferences regarding the nature of science, and we often misinterpret the meaning of the knowledge that we possess and teach.

The author touches here on the issue of significant complexity and the subject of permanent discourse: do we need to know the roots of our scientific knowledge? However, one cannot evaluate the necessity of such knowledge without familiarising ourselves with it, at least at the level of literacy. This book may facilitate such an effort by those who missed an education in this part of history. For some reason historical curricula missed this material in favour of endless wars and meaningless names of kings in succession. The much more noble part of history dealing with human attempts to understand the World—the history of science—is often left outside the history class at public schools.

My generation grew up with a clear image of the Middle Ages in Europe as an extremely dark period of human history: ignorance, illiteracy, primitive technology, savage cruelty, fanatical religion, and intolerance to others, crusades, pogroms, endless wars, lack of human rights, brutality of the inquisition and resistance to any intellectual progress including science. It is often thought that the change began in the following period—the Renaissance. Indeed, we may compare the medieval representation of the Crucifixion by Grunewald with the Renaissance one by Rafael, or the Hell of Bosch with that by Michelangelo.

James Hannam took on himself not a simple mission—to deconstruct this terrible image of the Middle Ages and show that the truth is much more complex. In all times and in all

I. Galili (✉)
Science Teaching Department, The Hebrew University of Jerusalem, 91904 Jerusalem, Israel
e-mail: igal@vms.huji.ac.il

places, there was a seed of divine spiritual intention in people's minds which, regardless of the particular environment, drove their minds in making sense of reality in terms of objective knowledge about Nature, its structure and the causality behind its numerous phenomena. The Middle Ages were not an exception in any way. It is these people with such spark of spirit whom James Hannam called *God's philosophers*. One may follow this trend of thought to Spinoza's pantheism and the God whom Einstein addressed in his famous: "I want to know God's thoughts; the rest are details."

James Hannam states that despite the great negative image which does reflect the reality of those times, it is not fully representative. One cannot ignore the great progress that took place at the same time in the scientific thought, within the natural philosophy. The readers learn that the accomplishments of the medieval scholars were truly impressive and they should reconsider the highly simplified image of that period. It became a commonplace to praise the highest quality of art, architecture and literature at the Middle Ages (it is still an ongoing process). Seemingly, the time has come to recognize the contribution of the medieval science. James Hannam fearlessly embarked upon this project. Science educators who will read the book may expand the impact of the same re-evaluation with regard to science education, at least by using the products of that period to illustrate and teach the important scientific concepts in the modern science course (Galili and Zinn 2007; Galili 2011).

It is clear that the book was written by a scholar. However, this is not a research monograph but a book for a broad audience, including those who lack the relevant background. Such is the majority of science educators, science teachers and science students. Hannam uses the advantages of a free, non-academic presentation and sometimes journalistic style to make the history readable, catching the reader's interest and making it possible to sample in fragments, when one has few moments to spare. Such reading is good for the uninitiated, to remove ignorance. It is up to the individual to decide whether or not to proceed, but regardless the decision, the main goal will be achieved—ignorance will be removed.

James Hannam deconstructed the one-sided image of the Middle Ages conceived as the time when science was abandoned and scholars were persecuted by the Church. The new picture revealed intensive intellectual life which included scientific accomplishments made by scholars, normally clerics, who in their highly devoted scholarship essentially developed human knowledge about nature and the method of science. Many readers who graduated from science departments will never have taken a course in the history of science. They will be surprised to see numerous results, often ascribed to Galileo, which were actually due to the bright minds of the Middle Ages: Buridan, Oresme, Nicolas of Cusa, Mertonian Calculators (Bradwardine, Heytesbery, Swineshead) and many other natural ("God's") philosophers. James Hannam not only mentions their names. Each of his heroes is given a brief but representative biography. This approach creates a feeling of understanding the scholar as an individual. At some pages the narrative becomes close to fiction: the author depicts intentions, feelings, and frameworks of thought, personal details and life problems of the hero. All these help better understand the outstanding individuals from the distant past, their claims and results.

To make the account concrete, as well as useful for the physics teacher of today, I arrange some of the scientific accomplishments in a list which includes "naïve" views regarding their origin juxtaposed with the true references as could be learned from Hannam's book.

Knowledge element	Naïve knowledge	Hannam in his book *God's Philosophers*
The metaphor of standing on the shoulders of giants to possess an ability to learn and develop further the complex knowledge	Newton	Bernard of Chartres and others from the 12th century (p. 1)
The metaphor of two books: scriptures and nature as the resource of knowledge	Galileo	Common conception in the Middle Ages philosophy (12th century) (p. 65)
Ascribing the figurative manner and non-literal meaning to the statements in the Bible	Galileo	Commonplace in the Middle Ages theology: William of Conches (13th century) (p. 63), Oresme (p. 187), Augustine (p. 315)
Relativity of motion (the context of moving ship, cabin in the ship)	Galileo (physical relativity)	Buridan, Oresme, Nicolas of Cusa (15th century) (kinematic relativity)
Thought experiment of a tunnel across the Earth (pendulum motion)	Galileo	Oresme, Albert of Saxony (14th century)
Requirement of precise measurement in observation	Galileo	Nicolas of Cusa (15th century) (p. 199)
Requirement to use mathematics in natural philosophy	Galileo	Merton calculators (p. 176), Oresme, Nicolas of Cusa (p. 187)
Velocity, acceleration, types of motion (uniform and uniformly accelerated)	Galileo	Merton school in Oxford (Bradwardine, Heytesbery, Swineheard) (14th century)
Mean-speed theorem and its geometrical demonstration	Galileo	Merton school in Oxford, Oresme (pp. 176, 188, 189, 332)
Graphical representation of functional dependence in physics (of motion)	Galileo	Oresme (p. 189)
Primary and secondary features/causes of physical objects/events	Galileo	Commonplace in the medieval philosophy, William of Conches (regarding 'natural laws') (13th century) (p. 62)
Experiment of two falling bodies of different weights	Galileo	Philoponus (experimental) (6th century), p. 177, Bradwardine (14th century) (in vacuum, p. 178), Domingo de Soto (theoretical) (p. 303), Benedetti (thought experiment) (pp. 301, 329) and Stevin (16th century) (p. 301)
Resolution–composition (analysis–synthesis) method	Galileo	Commonplace in the medieval philosophy
Replacement the Aristotle's theory of motion: removing the need for outside mover	Galileo	Buridan, Bradwardine, Oresme (impetus theory) (pp. 182–184)
Infinity of the World	Digges (16th century)	Nicolas of Cusa (15th century) (p. 198)
Motion (rotation) of the Earth	Copernicus, Galileo	Ancient Greek theories, (Buridan, Bradwardine, Oresme, Nicolas of Cusa) (p. 186)
Breaking Aristotelian separation in two worlds (sub- and supra-lunary)	Galileo, Kepler	Buridan, Bradwardine (ascribing impetus to the planets) (pp. 184,185)
Rotational inertia	Galileo (early)	Buridan, Bradwardine (p. 185)
Curved (parabolic) trajectory of projectiles	Galileo	Albert of Saxony (14th century)—compound trajectory, Tartaglia and Cardan (16th century) (pp. 334–335)

Knowledge element	Naïve knowledge	Hannam in his book *God's Philosophers*
Polarity of magnetism, compass, conception of spherical magnet	Gilbert (16th century)	Peter the Pilgrim (13th century) (pp. 140–141)

Many readers might be surprised to see the items of the table. Of course, the question arises why Galileo did not give any credit and did not mention the substantial contribution of the medieval scholars (and even of his predecessors in Italy). They actually equipped him both in content and method (could he achieve in science what he did without that knowledge?). Hannam hinted that Galileo seemingly preferred to talk to the wide public, bright individuals and the church, in the style of popular science argument (p. 323):

> This means that Galileo's 'Dialogue Concerning the Two Chief World Systems' is not a masterwork of science. Instead, it is a first-class piece of rhetoric aimed squarely at non-experts.

To a considerable extent, such was his major defence of Copernican system: dialogues with imaginary opponents—a layman and a flexible philosopher both easily persuaded. Importantly, the strongest opponent of Copernicus—Tycho Brahe—was ignored by Galileo, as well as Kepler whose astronomical discoveries were fundamental for physics. These facts deserve interpretation by those who do not agree with Hannam, together with the fact that the only argument of Galileo's for Earth's movement—the tides—was not only wrong, but also not well elaborated and strikingly contradicting the reality and his own relativity principle. Seemingly, Galileo the passionate disputationalist sometimes surpassed Galileo the careful scientist. Besides the case of tides, the same held for the case of comet dispute with Jesuit astronomer Grassi, in *The Assayer.* Much earlier, Tycho proved in 1577–1588 that comets are a heavenly phenomenon (pp. 282–283).

This is, of course, a separate issue, which might, at least partially, explain the naive and popular belief that modern science started from Galileo, just as it is thought that Christianity began from the Gospels (neither is true). Galileo was extremely popular and invested great effort and time to this end. The book by Hannam tries to prevent the eclipse of the rich and substantial legacy of the medieval scholars, a legacy that was available for the scholars at the days of Galileo but not to the students of science today. This makes its reading worthwhile.

Although, the physics teacher will benefit from the book, I should moderate the expectations: in many cases Hannam only mentions the discovery, idea or conception, but does not elaborate them sufficiently for a comprehensive understanding required for adoption in teaching practice. One needs to proceed to reading more disciplinary materials (Hannam provides a rich bibliography and a list of further readings). The resources mentioned by him are not new, but seldom used in physics education.

I may reflect briefly on religion and religious views of the scientists depicted in the book. First, the book clarifies to the uninformed modern reader some controversies: the important schisms in Christianity, East and West, reformation, resistance to Atomism, Church support for Aristotle, determinism and sin, reason and faith. These elements are not too numerous in the book and are presented in a way that is appropriate for general education: brief, simple and in its relation to the history of science. Hannam clarifies and corrects the inaccurate images of Roger Bacon and Giordano Bruno as martyrs of science, which they were not.

Secondly, James Hannam' presentation repeats the fact that all the fathers of modern science (Galileo, Kepler, Descartes, Newton) held highly religious worldviews and can be placed in the same line with the great Scholastic Scientists of the Middle ages who were all clerics. Faced with this continuous line, the reader may ask about the opposition of science and religion. Hannam does not treat this issue (which discussion in physics class might be greatly stimulated by the book). Instead, he addresses the specific perspective on the science-religion relationship in the Middle Ages to correct another myth of resistance to science. Thus, regarding the rejection of atomism which threatened the Catholic interpretation of Eucharist he said (p. 193):

> Certainly, this was a clear cut of theological orthodoxy curtailing philosophical enquiry. But this happened so rarely that we cannot maintain that the Church held back science in general.

He proceeded:

> The popular image of the medieval church as a monolithic institution opposing any sort of scientific speculation is clearly inaccurate. Natural philosophy had proven itself useful and worth supporting. It is hard to imagine how any philosophy at all would have taken place if the Church-sponsored universities had not provided a home for it

In several examples (including the case of Galileo) Hannam showed that the church did not act against science or scientists unless it found itself "in the corner", under a clear threat to its fundamentals, and this happened very rarely. And as to blind faith and violence usually ascribed to this period, Hannam states (212):

> The Renaissance was as much an age of faith as the Middle Ages and, if anything, even more superstitious and violent.

As to the dogmatism and blind following of ancient authority usually attributed to medieval scholars, Hannam rejects this popular image too. For example, Aristotle was often not taken to be unconditionally correct. First, when there was an obvious contradiction between Aristotle and scriptures, the scholars criticized and rejected Aristotle. Moreover, facing the arguments against Aristotelian theory of motion, the medieval scholars fundamentally reconstructed it and replaced it by impetus theory. By making it possible both to criticize Aristotle and to adopt his science, the medieval scholars opened the stage for continuous scientific research which led to great accomplishments. More than that, Hannam contrasted this significant progress with Renaissance (p. 212):

> The desire to look back to Greece and Rome was the true mark of the Renaissance, which in many ways was a conservative movement attempting to recapture an imaginary past rather than March forward. It was a time when, in order to be up to date in writing or architecture, artists had to model their work on a prototype that was over 1,000 years old.

In the great debate about God's creation—the world of things and phenomena—the medieval scholars recognized the stable order of reality, law-like regularity and reason that governs natural phenomena. In this, the medieval scientists in fact took the line of the Greek philosophers. In this picture, if we replace God with Nature we receive the view introduced by the scientific revolution of the seventeenth century. It implies rejection of voluntarism and subjectivism and adoption of objectivism—the genus of science, old and new.

Illuminating the nature of science, Hannam impressively demonstrates the leading role of *theory* in scientific knowledge. This is done while presenting a comprehensive picture of the history of medicine (Chap. 16). The story of medicine appears in the book as a real tragedy of the medieval ages. By following the wrong theory of Galen, it caused much more suffering than cure. Hannam follows the accumulation of criticism of Galen's theory through the development of anatomy in medieval science. In this regard, the myth removed by Hannam is that the medieval Church opposed human dissection (p. 255):

> If the Catholic Church had really objected strongly to human dissections, they would not have rapidly become part of the syllabus in every major European medical school.

Much to my surprise is the stance of medieval science and the Church regarding the pseudo-science of astrology. Hannam quotes Thomas Aquinas—the highest authority of the Church, the Evangelical doctor—who in his account surpassed millions of contemporary consumers of horoscopes. His mature view was (p. 125):

> If anyone attempts from the stars to foretell future contingent or chance events, or to know with certitude future activities of men, he is acting under false and groundless presumption and opening himself to the intrusion of diabolic powers. Consequently, this kind of fortune telling is superstitious and wrong. But if someone uses astronomic observation to forecast future events which are actually determined by physical laws, for instance drought and rainfall, and so forth, then this is neither superstitious nor sinful.

It should not be forgotten that there were very well addressed medieval accomplishments in technology. Hannam depicts in details the central achievements in medieval technology: optical spectacles, mechanical clock, astrolabe, new system of agriculture (ploughs, rotation in soil use), horse machinery (horseshoes, stirrups, horse collar, whippletree), magnificent cathedrals (pointed arch, flying buttress, rib vault), wind and water mills (complex gears mechanics). The invention of the mechanical clock (especially its heart—the escape mechanism) by Richard of Wallingford is described in all its glory and significance for scientific and cultural progress. A special section of technology—warfare machinery (The Physics of War) also receives a good account showing its impact on science through accumulation of data and experience for use in mechanics (lever, material characteristics, projectile trajectories, fluid dynamics).

The author summarises his descriptions by reconsidering the concept of scientific revolution which placed the Middle Ages below the threshold of a scientifically developed period. He criticizes the very concept (p. 342):

> This book should lend some support to the sceptics claiming that the term "the scientific revolution" is another one of those prejudicial historical labels that explain nothing. You can call any century from the twelfth to the twentieth a revolution in science, with our own century unlikely to end the sequence. The concept of scientific revolution does nothing more than reinforce the error that before Copernicus nothing of any significance to science took place at all.

This is a very important point that Hannam makes concerning knowledge change and preservation/accumulation. All too often we hear the view of the fragmentary nature of science, incommensurability of its different periods. People often take a statement that makes sense as a starting point. Indeed, say, medieval and classical physics are essentially different in their nuclei, hard cores. However, on a closer view, one discovers that both kinds of physics tackled the *same* problems and did so within the same scientific rationality. They both sought knowledge about *objective* reality and used previously accumulated data, concepts, knowledge. Therefore, they maintained *continuous objective and constructive discourse* regarding nature and natural phenomena. To a considerable extent this activity was neutral, and independent of the specific form. Yet, this view does not suggest ignoring the essential changes in science that took place in the seventeenth century (such as requirement of statements to be verified by reference to experiments with control parameters). Those who want to emphasise these *changes* may continue to use the notion of revolution. Hannam depicts another perspective which shows the *continuity* of science between Medieval and Modern science. As long as one is aware of both everything is fine.

One can easily feel that the author is strongly emotionally involved in his subject. To avoid an impression of personal bias and keep the strength of the presented picture he clarifies in his final words (p. 342):

> Life in the Middle Ages was often short and violent. The common people were assailed by diseases they did not understand; exploited by distant ruling class; and dependent on Christian church that rarely lived up the ideals of its founder. It would be wrong to romanticise the period and we should be very grateful that we do not have to live in it. But the hard life that people had to bear only makes their progress in science and many other fields all the more impressive. We should not write them off as supposititious primitives. They deserve our gratitude.

All together, this Hannam's book seems to me a very good textbook even if it lacks summaries and exercises. Instead it has a *List of Key Characters* which cites names with the features relevant to the book (pp. 345–358). The reader may check whether somebody missed paying attention in the 350 pages of the inclusive and panoramic view presented in the book.

I saw inaccuracies only in few places. In particular, the space arrangement of substances in the Aristotelian world was not in accordance to their weight, but the other way around: the weights of the elements were determined in accordance to their original cosmic order in Nature–earth, water, air, fire, aether (p. 139).

Furthermore, by ascribing impetus to the planets (p. 184) Buridan and other medieval scholars did *not* challenge Aristotle since for him the circular motion of the planets was natural (exactly as the free falling was) and as such did not require any effective cause—the mover. Ascribing impetus to the planets, however, signified a fundamental break with Aristotle: the division of the world into sub- and supra-lunary.

Finally, on page 329, the author wrote about the thought experiment of two falling objects of differing weights. It was indeed an ingenious piece of logical critique. It was reproduced by Galileo in his *Discorsi* (Galilei 1638/1914, p. 107) from the earlier publication by Benedetti (e.g., Dijksterhius 1986). However, the demonstrated inconsistency of the Aristotelian theory did not present any proof regarding the true nature of falling bodies in any other way: it just showed that Aristotle's theory was wrong, no more (Galili 2009). And indeed, Galileo did not state that he proved how the bodies should fall, but after stating the inconsistency of Aristotle, he proceeded to the *empirical* considerations to show that the bodies fall at the same rate. Galileo's law was empirical, not following from any theory (that he did not have). Within the theory of Newton, Galileo's law appears as a very good approximation valid only when one body is much larger than the other (Lehavi and Galili 2009). The erroneous statement regarding the proof by means of the thought experiment is, however, popular among physics teachers. Understanding its fallacy is educationally important.

Hannam's well written and interesting book may definitely facilitate a course for physics teachers, both in service and prospective, who seek preliminary knowledge of the history of science and the *cultural content knowledge* of physics to be provided in physics class by means of the history and philosophy of science (Galili 2011). This book may serve as an introduction. One may proceed to read further in the resources cited by the author in a special list and in the rich bibliography provided.

References

Dijksterhius, E. J. (1986). *The mechanization of the world picture. Pythagoras–Newton* (pp. 269–270). Princeton: Princeton University Press.

Galilei, G. (1638/1914). *Dialogue concerning two new sciences* [*Discorsi*]. NY: Dover.

Galili, I. (2009). Thought experiment: Establishing conceptual meaning. *Science & Education, 18*(1), 1–23.

Galili, I. (2011). Promotion of content cultural knowledge through the use of the history and philosophy of science. To be published in *Science & Education*.

Galili, I., & Zinn, B. (2007). Physics and art: A cultural symbiosis in physics education. *Science & Education, 16*(3–5), 441–460.

Lehavi, Y., & Galili, I. (2009). The status of Galileo's law of free-fall and its implications for physics education. *The American Journal of Physics, 77*(5), 417–423.